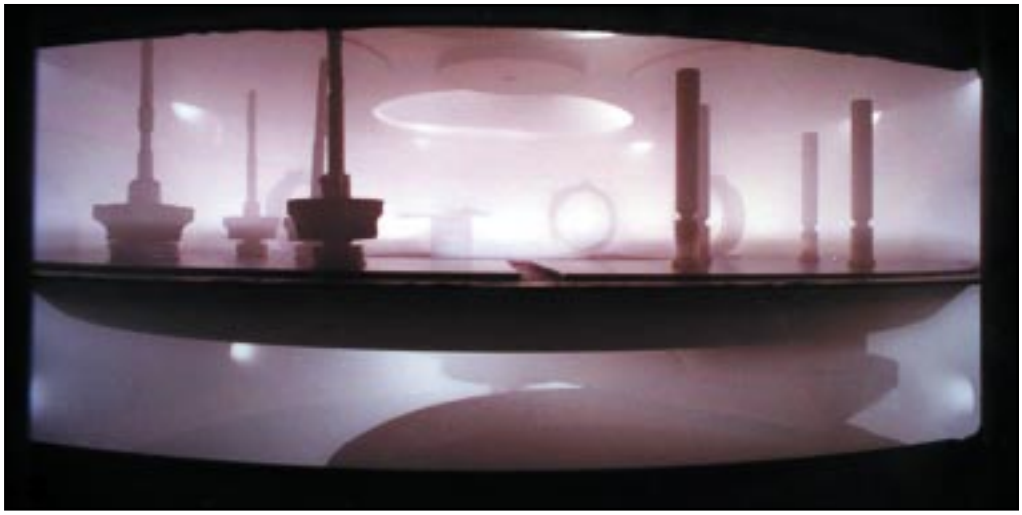
Coatings more durable than diamond help protect engine components

OAAT ACCOMPLISHMENTS

Near-Frictionless Carbon Film Coatings



The coatings are applied at high rates by ion-beam deposition, sputtering, or a plasma-assisted chemical vapor deposition system.

Challenge

Engine components that slide, roll, or rotate can have coatings applied to them that reduce friction, increase engine durability, and improve performance. However, it is often difficult, time-consuming, and expensive to apply these coatings to all types and shapes of automotive parts, such as those made of plastic, ceramic, or certain metals. In addition to offering easy application, friction-reducing coatings must be durable enough to withstand the heat and friction encountered in today's engines.

Technology Description

A near-frictionless carbon (NFC) film has been developed that is many times slicker than Teflon® and has the lowest coefficient of friction (COF) of any carbon-based material in the world. The new material's COF is less than 0.001 (measured in a dry nitrogen atmosphere), compared to Teflon's 0.04. The extremely durable material has a wear rate 100 to 1000 times lower than smooth diamond and lubricated steel, respectively. The film can be applied to almost every type and shape of automotive part at high rates by ion-beam deposition, sputtering, or a plasma-assisted chemical vapor deposition (PACVD) system operating at relatively low temperatures (room temperature to 200° C).

Accomplishments

Techniques were developed to apply thin (1-micrometer) films on practically any substrate by a variety of methods at temperatures sufficiently low to avoid damaging heat-sensitive materials. The NFC films exhibited exceptional wear resistance and durability.

An NFC film coating was applied to the radial journal and thrust air bearings of a turbo-compressor, a component that experiences numerous stop/start cycles. Frictional force on the 440° C steel material was reduced by four times, and the linear wear rate was reduced by two orders of magnitude.

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Benefits

NFC films adhere well to many kinds of substrates, including plastics.

Compared to previous methods of producing carbon coatings, the new deposition processes are fast – taking only a few hours – and are scalable to large batch production runs.

Near-perfect finished products have a smooth surface, uniform coverage, and good transparency. They do not require secondary machining or grinding.

The ultrahard coating of NFC films means longer lifetime and improved performance for rolling, sliding, and rotating components. The films' exceptional wear resistance and durability reduces material and energy losses during operation in automotive applications.

Awards

Finalist in the "Emerging Technology" category of the 1998 *Discover Magazine* Awards

1998 *R&D Magazine* "R&D 100" Award

Future Activities

Additional applications for NFC films will be investigated. Improved processes to deposit NFC films on metals and ceramics will be developed. The films' performance over a wide range of loads, speeds, and temperatures will be tested. Researchers will optimize tooling and process conditions to coat large batches of components at a reduced cost.

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